TEAM PERFORMANCE IN AERONAUTICAL AND SPACE ENVIRONMENTS

FINAL REPORT

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This is the final report of the work accomplished under agreement NCC 2-457 between NASA Ames Research Center and Harvard University.

Team Performance in Aeronautical and Space Environments: Final Report

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The overall objectives of the research conducted under our cooperative agreement with NASA Ames Research Center were (a) to conceptualize and empirically explore the major social and organizational influences on the performance of flightdeck and space crews, and (b) to assess the degree to which the effectiveness of flightcrews in line operations could be improved by alteration of the factors under study. Overall, the research was intended to contribute both to the advancement of scholarly knowledge about task-performing teams and to the development of practical knowledge about how best to design and manage teams that operate in the unique, and uniquely challenging, air and space environment. The work performed consisted of roughly equal measures of conceptual analysis, method development, empirical research, and application.

The conceptual work involved the development of new models of (a) the determinants of team performance effectiveness--with special emphasis on teams such as air crews whose work is inherently self-managing, (b) factors that affect the extent and direction of team influences on the beliefs, attitudes, and behavior of individual members, and (c) the role of leaders in shaping team dynamics--with special attention to the behavior of captains when crews first form.

The methodological work involved the development of a set of new methods for assessing the behavior and performance of flightdeck crews, including survey, observational, and archival instruments. These methods are based on the conceptual work accomplished under the agreement, and they were applied and refined in the empirical portion of the project.

The empirical research involved intensive study of over 300 intact crews flying ten different aircraft types in ten different air carriers (three U.S. civilian carriers, four overseas airlines, and three military flying units).

Finally, application of the findings was accomplished in three complementary ways: (a) through active involvement with government and industry organizations (such as the National Transportation Safety Board, the Federal Aviation Administration, and the International Air Transport Association) in attempts to provide performance-enhancing technological, organizational, and regulatory contexts for flight crews; (b) by working relatively intensively with a small number of civilian and military flight organizations to develop structures, policies, and practices that promote flightdeck crew effectiveness; and (c) by collaborating with staff at NASA and at the University of Texas on the development, implementation, and evaluation of crew-oriented flight training. The publications that report project findings are listed below, in five sections that roughly correspond to the research tasks specified in our research proposals to NASA. These tasks are:

1. Development of conceptual models that specify and organize the major influences on the performance effectiveness of flightdeck crews.
2. Development of instrumentation for collecting reliable and valid measures of the structure, context, and leadership of flightdeck crews.
3. Empirical analysis of the determinants of flightdeck crew performance across organizational and national contexts.
4. Empirical assessment of the timing and content of captains' leadership interventions on flightdeck crew behavior and performance.
5. Application of the research findings to operational environments and dissemination of implications to the aviation community.

Leadership for one research task specified in our proposal--namely, evaluation of the effects of Crew (or Cockpit) Resource Management Programs--was gradually assumed by the University of Texas research team under NASA support. Although we provided assistance in this large-scale assessment activity, empirical findings are to be found mainly in reports prepared by the Texas team. Finally, we note that one study contemplated in our proposal--a controlled partial analog experiment to be conducted jointly by researchers from Harvard, Texas, and Ames Research Center--was not carried out because of unanticipated reductions in both funds and available simulator time at the Ames facility.

Project Reports

Task #1: Development of conceptual models that specify and organize the major influences on the performance effectiveness of flightdeck crews.

Hackman, J. R. (1986). The psychology of self-management in organizations. In M. S. Pallak & R. O. Perloff (Eds.), Psychology and work. Washington, DC: American Psychological Association.

Hackman, J. R. (1986). Group level issues in the design and training of cockpit crews. In H. H. Orlady & H. C. Foushee (Eds.), Proceedings of the NASA/MAC Workshop on Cockpit Resource Management. Moffett Field, CA: NASA-Ames Research Center.

Hackman, J. R. (1987). The design of work teams. In J. W. Lorsch (Ed.), Handbook of organizational behavior. Englewood Cliffs, NJ: Prentice-Hall.

Hackman, J. R. (1989). Groups that fly: Lessons from cockpit crews for social psychological research and theory. Invited Address, American Psychological Society, Washington, DC.

Gersick, C. J. G., & Hackman, J. R. (1990). Habitual routines in task-performing teams. Organizational Behavior and Human Decision Processes, 47, 65-97.

Hackman, J. R. (1992). Group influences on individuals in organizations. In M. D. Dunnette & L. M. Hough (Eds.), Handbook of industrial and organizational psychology (Vol. 3). Palo Alto: Consulting Psychologists Press.

Ginnett, R. C. (forthcoming). Effectiveness begins early: The role of leadership in the formation process of intra-organizational task groups. Under editorial review.

Task #2: Development of instrumentation for collecting reliable and valid measures of the structure, context, and leadership of flightdeck crews.

Note. In addition to the reports listed below, we have prepared and have ready for use by other researchers both (a) a full set of research instruments for assessing the behavior and performance of flightdeck crews, including instructions for use of the instruments, and (b) a documented database from our empirical research on 300+ flightdeck crews from ten air carriers.

Hackman, J. R. (1987). Theory and method in research on crews in space. Paper presented at NASA Symposium on Three Decades of Life Science Research in Space, Washington, DC.

Orlady, L. R. (1987). Observing cockpit crew behavior and performance. Paper presented at the Fourth Symposium on Aviation Psychology, Ohio State University.

Hackman, J. R., & Helmreich, R. L. (1987). Assessing the behavior and performance of teams in organizations: The case of air transport crews. In D. R. Peterson & D. B. Fishman (Eds.), Assessment for decision. New Brunswik, NJ: Rutgers University Press.

Hackman, J. R. (1988). Studying groups in organizations: Some lessons from the field. Invited address, Canadian Psychological Association Annual Convention.

Task #3: Comparative analysis of the determinants of flightdeck crew performance across organizational and national contexts.

Ginnett, R. C. (1988). Cockpit crew effectiveness from the inside out: A micro analysis leading to macro considerations. Proceedings of the 11th Annual Psychology in the DOD Symposium, U.S. Air Force Academy.

Hackman, J. R. (Ed.). (1990). Groups that work (and those that don't). San Francisco: Jossey-Bass.

Hackman, J. R. (1992). Where the variance lives: Continuity and change in social behavior. Invited Address, American Psychological Society, San Diego.

Hackman, J. R. (1994). Cross-organization commonalities in the design and leadership of flightdeck crews: The impact of technology, regulation, and the culture of flying. Briefing to the National Transportation Safety Board, Washington, DC. (Manuscript being prepared for journal publication.)

Katz, N., & Hackman, J. R. (forthcoming). Flying together: How shared mental models develop among cockpit crew members. Manuscript in preparation.

Task #4: Empirical assessment of the timing and content of captains' leadership interventions on flightdeck crew behavior and performance.

Ginnett, R. C. (1987). First meetings of cockpit crews: Their dynamics and effects. Paper presented at the Fourth Symposium on Aviation Psychology, Ohio State University.

Ginnett, R. C. (1987). Is the "right stuff" right? The leader's role in crew formation and development. Paper presented at NASA Symposium on Three Decades of Life Science Research in Space, Washington, DC.

Ginnett, R. C. (1990). Airline cockpit crews. In J. R. Hackman (Ed.), Groups that work. San Francisco: Jossey-Bass.

Ginnett, R. C. (1991). Effectiveness begins early: The leadership role in the formation process of intra-organizational task groups. Under editorial review.

Task #5: Application of the research findings to operational environments and dissemination of implications to the aviation community.

Note. In addition to the papers listed below, we have reported project findings at a number of symposia, workshops, and conferences sponsored by organizations such as NASA Ames Research Center, NASA Johnson Space Center, National Transportation Safety Board, Federal Aviation Administration, U.S. Air Force Military Airlift Wing, U.S. Air Force Aeromedical Airlift Wing, the Parliamentary Advisory Council on Air Safety (United Kingdom), and a number of domestic and overseas air carriers.

Ginnett, R. C. (1987). Cockpit resource management: Where we are today. Paper presented at the Strategic Air Command Airmanship Conference, Ft. Worth, TX.

Hackman, J. R. (1989). Resource management training and cockpit crew coordination. Proceedings of the Seventh General Flight Crew Training Meeting of the International Air Transport Association, New Orleans.

Hackman, J. R. (1989). What it takes for cockpit resource management training to make a difference in line flying: The critical role of organizational and regulatory contexts. Paper presented at the Senior Executive Seminar on Human Factors, Federal Aviation Administration, Rutgers University, New Brunswik, NJ.

Hackman, J. R. (1990). New directions in crew-oriented flight training. Proceedings of the ICAO Human Factors Seminar, Leningrad.

Hackman, J. R. (1992, 1993). Rethinking crew resource management. Air Line Pilot. Part I: Flight deck crews as teams (December, 1992). Part II: The captain as team leader (January, 1993). Part III: The organizational context (February, 1993). Note: This series of articles was reprinted in Flightdeck, published in the U.K. by British Airways.

Hackman, J. R. (1993). Teams, leaders, and organizations: New directions for crew-oriented flight training. In E. L. Wiener, B. G. Kanki, & R. L. Helmreich (Eds.), Cockpit resource management. Orlando, FL: Academic Press.

Hackman, J. R. (1995). The revolutionary implications of using social science knowledge to enhance cockpit crew effectiveness. Paper presented at the Learning Research and Development Center, University of Pittsburgh. (Manuscript being prepared for journal publication.)

Ginnett, R. C. (forthcoming). Cockpit crew leadership: Getting the most from human factors. Under editorial review.